

RESEARCH COMMUNICATION FOR IMMEDIATE IMPACT: CLIMATE ADAPTATION IN AUSTRALIA

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KEYWORDS: applied research, end user, engagement, communication, climate change

ABSTRACT

Research into climate change adaptation is challenged by funding organisations to demonstrate immediate research impact through near term reference in sector-specific communication and policy documents. Critically, research funded to inform decision makers and current policy about adapting to climate change must engage with end users and implement communication initiatives that lead to research adoption. Moreover, researchers need to better understand the components that contribute to effective engagement and communication to plan successful strategies to engage with the range of vulnerable sectors affected by climate change. Given the importance of research application, Primary Investigators for National Climate Change Adaptation Research Facility (NCCARF) funded projects had to consider end user engagement and communication. This paper identifies some common factors in three NCCARF cases which successfully demonstrated swift access to climate adaptation research in three sectors; human health, emergency management, and settlements and infrastructure. Early and ongoing engagement between researchers and the intended knowledge users shaped both the research focus and output formats. Stakeholders involved in coordinated and sustained communication programs disseminated and promoted the research through multiple channels. These agents of dissemination included; funders (NCCARF, universities and industry bodies); information users (government agencies and professional bodies), and both mass media and social media.

INTRODUCTION

There is increasing awareness of the need to factor current and expected impacts from climate change into decisions that require long term investments, have long range consequences or that may limit adaptation options for the future (Boyd et al., 2011; Moser, 2011). The on-going divide between people who need evidence-based information to make decisions and those who do research to produce that new knowledge creates a communication barrier which has grave implications if it is not

Recommended citation:

Coulter, L., Rissik, D. & Zhong, J. (2015). Research Communication For Immediate Impact: Climate Adaptation In Australia. In: N. Longnecker, C. Harris & K. Madden (Eds.), *Proceedings of the Australian Science Communicators National Conference*. 2–5 Feb, 2014, Brisbane. www.asc.asn.au/publications/

addressed explicitly from the outset of research design and investment (Besley & Nisbet, 2013; Gibbons et al., 2008; Maria Carmen, Christine, & Vijay, 2012; Suleski & Ibaraki, 2010). Due to the wide range of likely climate impacts which affect multiple sectors, there are many audiences for this information. Each have existing distinct and familiar communication channels and trusted sources (Myers, Nisbet, Maibach, & Leiserowitz, 2012; Nisbet, 2009). This diversity poses a significant challenge in Australia for nationally coordinated research communication such as that implemented by the National Climate Change Adaptation Research Facility (NCCARF). Answering a call in the 2007 Council of Australian Government (COAG) National Climate Adaptation Framework, NCCARF was tasked to 'provide governments, industry and the community with clear and reliable information to assess risks and develop adaptation strategies' (Council of Australian Governments, 2007). To appropriately deliver research suited to specialised users and to be seen as credible sources in the politicised environment surrounding climate science (Lupia, 2013), NCCARF researchers were encouraged to actively engage with identified research users.

According to the Department of Innovation, Industry, Science and Research review of publicly funded research, academic citations remain the dominant evaluation metric of research success, even for projects where stakeholder application is a primary objective (DIISR, 2011). However, a recent trial supported by Australian universities offers an alternative structure based on the UK Research Excellence Framework which uses case study assessments (ATN & Go8, 2012). Successful communication of new knowledge to support climate change adaptation could reasonably be gauged by the swift or wide dissemination of such knowledge in vulnerable sectors and populations, and through reference by decision makers in policy and business.

In this research paper we aim to gain a deeper understanding of effective communication with priority stakeholders in federally funded NCCARF research projects from the sectoral focused Adaptation Research Grants Program (ARGP). While the NCCARF sister program, Synthesis and Integrative Research, is essentially interdisciplinary by design, we chose cases from the ARGP which offer clear differences between users through its sectoral focus. We characterise the engagement and communication methods found in three ARGP climate adaptation research reports frequently accessed by information users. We then review the different elements of success depending on user needs, before proposing an approach for researchers to identify end users and communication strategies.

METHODS

We selected three cases from among the top ten downloaded ARGP reports from the NCCARF website as of 27 October 2013 (see Table 1). As reports have been published for differing lengths of time we expect that other projects will also achieve significant impact in the coming months, however, the reports featured here were selected because they have already attracted hundreds of users within six to twelve months post publication. These cases represent different sectors' stakeholders ranging from health and emergency managers concerned with heat waves, to local governments and roads asset managers, to policy makers and researchers accounting for the public's understanding of climate change and adaptation. We

Table 1: Case study research projects, download rank and objectives

Host Institution	Research Final Report	Downloads by 27/10/13	Objectives stated in final report
CASE 1 Monash University	Loughnan, M. E., Tapper, N. J., Phan, T., Lynch, K., & McInnes, J. A. (2013). <i>A spatial vulnerability analysis of urban populations during extreme heat events in Australian capital cities</i> (p. 128). Gold Coast: National Climate Change Adaptation Research Facility.	Since 07/01/13 1620 (1 st)	"...to provide an analysis of the spatial distribution of vulnerability of urban populations to extreme heat events in Australian capital cities at the present time, and to estimate future vulnerability in relation to projected climate changes. "
CASE 2 University South Australia	Balston, J., Kellett, J., Wells, G., Li, S., Gray, A., & Iankov, I. (2012). <i>Quantifying the cost of climate change impacts on local government assets</i> (p. 219). Gold Coast: National Climate Change Adaptation Research Facility.	Since 14/11/12 1069 (2 nd)	"...to identify key Council assets vulnerable to climate change; determine the likely impacts of climate change on Council assets; undertake a financial risk modelling exercise to quantify in monetary terms climate change asset risk; develop the necessary modifications to existing asset management and financial sustainability tools so that Councils may evaluate various climate change action scenarios at the management planning level and ultimately guide service level standards."
CASE 3 Griffith University	Reser, J. P., Bradley, G. L., Glendon, A. I., Ellul, M. C., & Callaghan, R. (2012). <i>Public risk perceptions, understandings, and responses to climate change and natural disasters in Australia, 2010 and 2011</i> (p. 245). Gold Coast: National Climate Change Adaptation Research Facility.	Since 18/12/12 433 (7 th)	"...to document, examine and monitor public risk perceptions, understandings, and responses to climate change and natural disasters; the psychological and social (psychosocial) environmental impacts of the threat of climate change and natural disasters and, measuring and monitoring important psychological and social changes in the human landscape in response to the threat and unfolding environmental impacts of climate change."
CASE 3 Griffith University	Reser, J. P., Bradley, G. L., Glendon, A. I., Ellul, M. C., & Callaghan, R. (2012). <i>Public risk perceptions, understandings and responses to climate change in Australia and Great Britain</i> . Gold Coast: National Climate Change Adaptation Research Facility.	Since 10/10/12 347 (10 th)	"The multiple shared objectives of the UK and Australian surveys included documenting public perceptions and attitudes with respect to energy options and climate change considerations, as well as associated public understandings, concerns, and acceptance of policy alternatives. The Australian research also included a specific mandate to examine the nexus between climate change and natural disasters with respect to public perceptions, understandings, and responses."

identify the host research institution for each project as they are important stakeholders with the capacity to promote research findings through established communication channels. In addition we include the research objectives as briefly laid out in each final report.

The objectives stated in the final research reports offer insight into what engagement and communication programs best suit the purpose for both researchers and users. Although small, this sample set was selected to examine communication with vulnerable sectors that need information to adapt to the impacts from climate change. Primary Investigators of NCCARF research projects identified who will need to use the research to support adaptation to climate change and indicated how users would be involved in both the research and its communication (see Table 2). While researchers indicated how users would access the research during and after the project they were not required to plan promotion of research findings. ‘Promotion’ was included as an assessment criteria to understand why some projects were more frequently accessed than others. Aside from active promotion, some elements of chance contributed to public interest in topics depending on external events that affected media interest. We selected case studies to highlight how different communication methods were used to deliver information to end users with different needs, and we identified assessment criteria accordingly (Table 2).

Table 1 User engagement and communication assessment criteria

USERS	Identify users for the information the research will generate, considering policy, planning and management.
INVOLVEMENT	How will information users be involved in the project and its communication activities?
ACCESS	How will users access the knowledge your project will generate during the project lifetime?
DISSEMINATION	How will users access the knowledge your project will generate after the project is completed?
PROMOTION	How did the researchers and stakeholders promote the research findings?
UPTAKE	Was the research accessed and used to communicate?

Interests of divergent audiences were addressed within each project, while common factors in research plans influenced the process for user engagement and communication. Typically the plans: 1) identified users at the start who need the information for policy, planning and management, 2) involved stakeholders throughout the research process, 3) interacted with users as the projects progressed and 4) used existing user communication channels to deliver information. Using these common factors among projects we compare the engagement and communication activities and discuss their suitability for the intended information users and broader audiences.

CASES

While more than 33 institutions have hosted NCCARF projects and contributed differently to their engagement and communication, some factors are common to all. The NCCARF website (www.nccarf.edu.au) provided publicly accessible information about the projects during their research process, and after publication, linking research final reports to relevant materials. In addition, NCCARF arranged for all

research reports to be accessed on the websites of Terra Nova (the newly developed Australian Climate Change Adaptation Information Hub), Australia Policy Online (a research database for public policy development and implementation in Australia and New Zealand) and the National Library of Australia (NLA). In addition, the NLA archives the NCCARF website each year through its Pandora program, ensuring the government funded research information is retained and publicly accessible. Over the course of the research programs NCCARF held sector specific meetings initially for researchers, and then for policy and user communities. These facilitated understanding of climate adaptation requirements in Australia and promoted the emerging research findings to key stakeholders. Each year NCCARF also held an interdisciplinary conference where researchers, decision makers and practitioners came to exchange knowledge. Finally, the eight NCCARF Adaptation Research Networks also promoted adaptation research, fostered research capacity and held public meetings and workshops to raise awareness of climate change adaptation and disseminate research findings.

CASE 1 HEAT AND HEALTH

Report: *A spatial vulnerability analysis of urban populations during extreme heat events in Australian capital cities*

This project aimed to support climate adaptation strategies for extreme heat events by addressing the knowledge gap identified in the National Climate Change Adaptation Research Plan for Emergency Management: 'understanding the nature and location of the risks from climate change related natural disasters' (Pearce et al., 2009). As identified in the objectives the research findings were aimed to be useful to those involved in managing vulnerable populations exposed to extreme heat events in Australian capital cities through planning, implementing early warning systems and preparing prevention and response strategies for (see Table 3). To address a clearly identified and nationally articulated knowledge gap in public health and safety, this project engaged with the agencies intended as information users to provide research data, actively involving users in the research as stakeholders. The reference group included state and federal health departments while ambulance services contributed data.

This report stimulated intense media interest and was connected to new stories nationally and internationally for unusually long periods at a time where specialised science reporting in the media was diminished. Three communication initiatives supported this. Firstly, six months before publication, the Primary Investigator Dr Margaret Loughnan took part in the online media briefing, *Staying healthy in extreme weather*. Organized by NCCARF and the Australian Science Media Centre (AusSMC) to coincide with the 2012 Climate Adaptation in Action Conference, Dr Loughnan addressed the question 'How hot is too hot? What is the temperature for each Australian capital city above which heat-related mortality and morbidity increase?' (AusSMC, 2012). The resulting coverage was carried by the Australian Associated Press (AAP), Herald Sun and Nine MSN. Secondly, Monash University issued a press release on the publication through their Media Centre and Dr Loughnan made herself consistently available for interviews for over a week. Finally,

an article by Dr Loughnan titled 'Strategies for coping with extremely hot weather', appeared in The Conversation, a popular online source of news and analysis from the academic and research community.

Table 2 Engagement and communication evaluation – Case 1

Report Title	<i>A spatial vulnerability analysis of urban populations during extreme heat events in Australian capital cities</i>
Identified Users	General: Residents of Australian capital cities, especially those involved in preparing for and addressing extreme heat events Expert: Reference group: University of Sydney, NT Dept. of Health and Families, WA Dept. of Health, QLD Dept. of Health, VIC Dept. of Health, SA Dept. of Health, TAS Dept. of Health, Federal Dept. of Health and Ageing
User Input	NCAR Research Applications Laboratory Boulder, CSIRO, Council of Ambulance authorities, NSW Department of Health, VIC Ambulance Service, TAS Ambulance service, QLD Ambulance Service, NT Department of Health, St John's Ambulance WA, SA Dept. of Health, Canberra Ambulance Service, Department of Epidemiology and Biostatistics - State University of New York, CRC for Water Sensitive Cities, Monash University
User Involvement	Users were mainly included as data suppliers and contributors to the extensive literature review
Access	Access by users to information during the research process was through ad hoc contact with researchers in face-to-face meetings, email and telephone conversations.
Dissemination	NCCARF, APO, Terra Nova, NLA, sent directly to identified users, Cloud document hosting through Google Books and Yumpu. requested by colleagues and users, invited conference presentations
Promotion	AusSMC advance media briefing, Monash University press release, Margaret Loughnan interviews and article in The Conversation, additional production of Publicly accessible vulnerability maps
Uptake	In use by the CRC for Water Sensitive Cities; the Office of Living Victoria and cited in Australian Medical Association Answers to Question on Notice submission, Senate Inquiry, Recent trends in and preparedness for extreme weather events.

External factors played a role in the extensive media coverage this report attracted, such as the higher likelihood that health focused research findings get media attention as the most frequently reported science news is medical related (Suleski & Ibaraki, 2010). Additionally, by mapping vulnerability in all capital cities the report was locally relevant to a broad public from senior decision makers all the way to individual householders. The external event that most influenced media coverage at the time of publication was the extended, and record breaking, heat wave in Australia (BoM, 2013). The heat wave drew international attention to both public health concerns and the connection to expected climate change impacts. In Australia Dr Loughnan was quoted, or the report referenced, by most News Limited newspapers, including the Herald Sun and The Australian, as well as the ABC and a number of regional radio stations. Internationally, stories in the Jakarta Globe and Bloomberg online were linked to the Monash University press release. Mapping community vulnerability to heat and making those maps easily accessible made the data useful to a wide

audience. The focus on Australian capital cities and the spatial distribution of vulnerability in urban areas immediately made this information locally tailored for well over 80 percent of the Australian population. The vulnerability maps were generated by specialty software so the flattened images of the outputs published in the report did not allow access to the detailed data contained in each map. Recognising the great value of making this easily accessible to other researchers, decision makers and the public, additional funds were allocated to deliver spatial distribution maps for each city using a Google Map interface at <http://www.mappingvulnerabilityindex.com>.

Uptake

From 1 January to 27 October 2013, 331 new users came to the NCCARF website by landing on the Loughnan publication page directly, making it the 10th most frequent new entry to the site during that time. This report was cited in the Senate Inquiry, *Recent trends in and preparedness for extreme weather events* (Simon, 2013). It was part of the April 2013 Answers to Question on Notice submission by the Australian Medical Association to detail Australian studies or reports that 'quantify the relationship between extreme heat and mortality or morbidity rates' (AMA, 2013).

The report was referenced prepublication in the book *Schooling for Sustainable Development* (Robertson, 2012) and more recently in *The State of Australian Cities 2013* (Department of Infrastructure and Transport-Major Cities Unit, 2013) and the journal *Global Health Action* (Hansen, Bi, Saniotis, & Nitschke, 2013). Both maps and text have been used in an article on urban heat islands (Trundle, Bosomworth, & McEvoy, 2013) and a report on heatwaves and social vulnerability in Victoria (VCOSS, 2013).

According to an email to the authors, (M. Loughnan, personal communication, 28 October, 2013) the CRC for Water Sensitive Cities, a project partner, is using the work extensively for urban reform and heatwave mitigation. This includes urban planning, landscape architecture, and in the water industry across the country. The Office of Living Victoria requested a short report on the research and it's potential application. Additionally, the work has been linked online from the World Meteorological Association, Smithsonian/NASA Astrophysics Data System, Development Gateway, Zunia, and South Australia Policy Online.

CASE 2 LOCAL GOVERNMENT ASSETS

Report: *Quantifying the cost of climate change impacts on local government assets*

Part of the Settlements and Infrastructure theme, this ARGP research project developed a nationally applicable tool to help councils reflect climate change impacts on assets shown in financial and asset management plans (see Table 4). Addressing important climate adaptation issues is highlighted in the National Climate Change Adaptation Research Plan for Settlements and Infrastructure (Thom et al., 2010); the research is focused on roads and road works which represent approximately 80 percent of council assets in Australia (Balston et al., 2012). Researchers held detailed discussions with the Local Government Association South Australia (LGA SA) and the Institute of Planners and Water Engineers Australia (IPWEA) throughout the project.

In this case information designers became involved stakeholders who contributed to creating a tool they knew could be used in existing software and professional practice. Users were involved from the initial scoping meeting, sat on the steering committee and made use of an online information sharing website which was set up for discussion and to share documents including meeting minutes.

Table 3 Engagement and communication evaluation - Case 2

Report Title	<i>Quantifying the cost of climate change impacts on local government assets</i>
Identified Users	General: Council residents concerned about roads, asset costs and climate change Expert: Local councils in Australia, council asset managers and engineers, council financial managers
User Input	Local Government Association SA, Dept. of Environment, Water and Natural Resources (DEWNR)-SA, BoM Climate Division-SA, Institute of Public Works Engineering Australia (IPWEA), Murdoch University, Dept. of Planning, Transport and Infrastructure (DPTI) SA, Infra Plan, CSIRO, Municipal Associations of Victoria, WA Local Government Association, Shire of Esperance, Brighton Council, Bass Coast Shire Council, District Council of Tumby Bay, City of Port Adelaide Enfield, Campbelltown City Council, Wattle Range Council, Hume City Council
User Involvement	Bureau of Meteorology Climate Division South Australia, City of Onkaparinga and ten councils from SA, VIC , WA and TAS collaborated from early stages, attended stakeholder meetings, provided input to the methodology, asset and financial data and gave feedback on the tools developed
Access	During the research users met monthly for full day working sessions and accessed an information sharing website
Dissemination	Final project report posted to NCCARF, APO, Terra Nova and NLA websites, and sent directly to identified users, The tool developed through the project, a financial simulation model that calculates the impact of changes in temperature and rainfall on the useful life and maintenance costs for roads, was incorporated with widely used software system.
Promotion	Direct contact and peak body support, software integration and application workshops in three capitol cities, requested by colleagues and practitioners, invited conference presentations
Uptake	1069 Downloads as of 27/10/13. In use by majority of Local Councils in SA and many in Tasmania, Victoria, Western Australia.

Every month the entire research group met face-to-face with invited stakeholders and experts involved in issues relevant at the time. After the first six months a stakeholder engagement meeting brought everyone together to explain the project scope and preliminary findings and ask for user input about the research direction and output formats.

Research design was constantly influenced by user input. Closer to completion, another stakeholder workshop involved council representatives and Institute of Public Works and Engineers Australia representatives to discuss which results would be most valuable and what temporal and spatial scale and interface would be most useful. Once climate change scenarios were incorporated into the tool, it was demonstrated and tested with councils who supplied their data and feedback so

users had constant input into information delivery and selecting which outputs were actually useful to them (Balston et al., 2013).

In dealing with a large number of local councils, it was important that the research team formed a functional partnership with peak bodies influential with the users. State government support to integrate climate change impacts in planning for South Australia allowed the Local Government Association of SA to endorse the project and extend some financial support. On a technical level partnership with IPWEA was essential to design and calibrate the new module to fit with their existing asset management software. The project also benefited from financial and in-kind support by the 10 collaborating Councils.

Integrated into the national data set and financial modelling system, project results are now a nationally available plugin for all engineers and asset managers wanting to include climate change impacts into financial assessments concerning roads. Based on anticipated changes in temperature and rainfall, the methods could be extended to other assets or climate variables.

Uptake

From 1 January to 27 October, 2013, 133 new users came to the NCCARF website by landing on this publication page directly, more than half during the final 30 days. This surge coincided with increased software installation by local councils to apply the research in their planning system. This project was selected as a Climate Change Adaptation Good Practice Case Study which provides further detail and offers suggestions for future application (Balston et al., 2013).

After publication of the final report, three workshops were run across southern Australia in Perth, Adelaide and Melbourne with local government engineers, asset managers and financial managers. The outputs from these workshops contributed to an addendum that extended the findings of the original project. The addendum provides context to the original report, expands on the financial model, and in collaboration with IPWEA, enhances the decision support tools to include additional climate data sets for a total of 75 local government areas across southern Australia. IPWEA took on responsibility for the model and model updates and have integrated it into their system. Now anyone who uses the software sees an option to include climate change in forward projections for their council (J. Balston, personal communication, 10 October 2013).

Councils who provided data were the first to integrate the tool but some councils need to upgrade asset data to better reflect the quantity and types of road in the council area to use this new module. The need for data updates uncovered a benefit by clarifying to councils the sort of information needed to make informed asset management decisions taking into account climate change. In addition, recent legislation in South Australia requires councils to have long term asset management plans that rely on the improved data.

CASE 3 PERCEPTIONS, UNDERSTANDINGS AND RESPONSES

Report: *Public risk perceptions, understandings, and responses to climate change and natural disasters in Australia, 2010 and 2011*

One of the initial ARGP projects delivered the final report: *Public risk perceptions, understandings and responses to climate change in Australia and Great Britain* (see Table 5). The project coordinated national survey findings from a collaborative and cross-national research project undertaken by Griffith University (Australia) and Cardiff University (UK) (Reser, Bradley, Glendon, Ellul, & Callaghan, 2012a) .

Table 4 Engagement and communication evaluation - Case 3

Title	<i>Public risk perceptions, understandings, and responses to climate change and natural disasters in Australia, 2010 and 2011</i>
Identified Users	General: multiple organisational end users, interested individuals, and an international research community Expert: Federal and state government bodies, disaster engaged organisations, ie Australian Red Cross, the Australian Psychological Society (APS), Emergency Management Australia, and Municipal Councils such as the Cairns Regional Council. Also national and international research organisations and researchers including fellow climate change researchers, our funding bodies, federal and state level government policy advisers, the Pacific region authors of the Fifth Assessment Report for the Intergovernmental Panel on Climate Change (IPCC).
User Input	Study founded on survey responses from geographically and demographically stratified national sample of 4347 individuals and followed a similar survey of 3096 respondents conducted in mid-2010.
User Involvement	The initial funded program in 2010 involved considerable discussion and consultation with named end users. The subsequent study involved collaboration with the research community especially through the American Psychological Association Taskforce on Psychology and Climate Change and the APS Reference Group on Climate Change and Environmental Problems, as well as through other ongoing research collaborations.
Access	During the research process user access was mainly through survey responses and face-to-face presentations at forums, workshops and conferences with an initial interim research report generated and published by NCCARF following the 2010 survey, to meet myriad requests for these initial findings by government bodies as well as other researchers.
Dissemination	NCCARF, APO, Terra Nova, NLA, sent directly to identified users, requested by colleagues, invited conference presentations
Promotion	AusSMC advance media briefing, Griffith University press release, Joseph Reser interviews and article in <i>The Conversation</i> , related article in <i>American Psychologist Special Issue</i> .
Uptake	433 Downloads to 27/10/13 (+ 347 Downloads to 27/10/13 for <i>Public risk perceptions, understandings and responses to climate change in Australia and Great Britain</i>) Referenced in 2012 APS submission to the Productivity Commission Report on Barriers to Effective Climate Change Adaptation, Evidence to Senate Environment And Communications References Committee Extreme weather events, 20/02/13 in Hansard.

The follow-up study, *Public risk perceptions, understandings, and responses to climate change and natural disasters in Australia, 2010 and 2011* offered insight into the shifting nature of public perception of risks from climate change (Reser, Bradley,

Glendon, Ellul, & Callaghan, 2012b). Both studies placed in the top ten downloads out of more than 160 separate reports from the NCCARF website and their engagement and communication are treated here together. From 1 January to 27 October 2013, 543 new users came to the NCCARF website by landing directly on the web page for the later publication, making it the fourth most frequent entry to the site during that time, with the home page ranking first.

Although research end users are most often characterized as outside of the research community, this project counted researchers, especially those from fields other than psychology, as important information users and stakeholders. The foundation of this study was an interdisciplinary investigation of perceptions and behavior relating to environmental issues that arise from climate change. In addition to disaster and health management authorities, this study lists researchers as important information users, acknowledging the many communities involved in the interdisciplinary research needed to address climate change issues. While scientists traditionally build on each others' work and familiarise themselves with new knowledge through peer reviewed journals and discipline-specific conferences, few have time to look beyond their own field. Although social and decision sciences play a significant role in communicating uncertain climate risks (Pidgeon & Fischhoff, 2011) they are often neglected in climate change science research agendas and discourse. To address this, the report was couched in language that would engage researchers in other fields as well as policy makers and the interested public.

With such a broad range of eventual users for this information, effective face-to-face user engagement during the project mainly took place at meetings and conferences. To maintain a focus on bridging the boundary between psychology and climate science the work was presented at interdisciplinary conferences. An interim report was published which allowed the work to be cited in a special issue of the *American Psychologist* (Reser & Swim, 2011) in advance of the final report publication.

An active communication plan, including policy focused press releases for both reports by Griffith University, met with an interested audience for this report. The findings were relevant to political coverage, characterizing views on the reality and causes of climate change which has become a politicized topic. They also contradicted the commonly espoused idea that a substantial portion of the Australian public were sceptical that climate change is real. Professor Reser often made himself available for interviews and wrote three articles for *The Conversation*, one of which generated over 200 public comments.

Uptake

The earlier study in case three and its Interim report have been referenced in the Australian Psychological Society (APS) submission (APS, 2011) to the Australian Government Productivity Commission Report on Barriers to Effective Climate Change Adaptation (Productivity Commission, 2012). In addition, Professor Reser gave evidence to the Australian Senate Environment and Communications References Committee regarding extreme weather events, in support of another submission by the APS which referenced this later report (APS, 2013). As Hansard transcripts of public hearings are made available on the internet when authorised by the committee, findings from this research are now publicly referenced in official

Hansard records (Official Committee Hansard SENATE, 2013). In terms of academic impact, an article in the 2011 American Psychologist special issue (Reser and Swim, 2011) referring to the earlier NCCARF report had been cited in 18 publications as of 27 October, 2013.

ENGAGEMENT AND COMMUNICATION STRATEGIES

While there are many overlaps, across the three cases we identified three basic strategies used to both engage users in the research and to communicate research findings (see Table 6). Here we characterize the engagement and communication methods found in the three climate adaptation research reports frequently accessed by information users. Firstly, users were involved in research as data suppliers and output designers. Secondly, researchers supported other stakeholders to disseminate information. Thirdly, practical communication products were developed and formatted to suit the user needs in that sector.

Table 5 Overview of engagement and communication strategies

Research Project	Strategies		
	Data	Dissemination	Application
A spatial vulnerability analysis of urban populations during extreme heat events in Australian capital cities	information sources as stakeholders	media interviews	Public access vulnerability map
Quantifying the cost of climate change impacts on local government assets	information designers as stakeholders	peak body partnership	integration with user software
Public risk perceptions, understandings, and responses to climate change and natural disasters in Australia, 2010 and 2011	Research community as stakeholders	media interviews	interdisciplinary publications and presentation

DISCUSSION

The purpose of our study was to use some of the most successfully communicated NCCARF research projects to characterize their engagement and communication methods and review how these methods align with information needs of the users and to put forward a strategic approach to user engagement and communication planning for applied research projects. This is important to both provide evidence of dissemination to key stakeholders and to enable research adoption by the intended users to inform decisions, policy and practice. While application of findings from academic publications is often measured through citations, there is usually a time lag of years, rather than months, between research and research publication and then again between research publication and subsequent citations. Similarly, applications of new knowledge by policy makers and industry or professional practitioners will progress in line with long term political, bureaucratic and business cycles and then, only if they are found to be useful and credible (Lupia, 2013).

In these cases early and ongoing engagement between researchers and the intended users of new knowledge shaped both the research focus and the useful format of the outputs. Additionally, by involving stakeholders in coordinated and

sustained communication programs, the research was disseminated and promoted through multiple channels by invested parties. These included; funders such as NCCARF, universities and industry peak bodies; information users, such as government agencies and professional bodies, and both mass media such as news services involved in print, radio and television and social media.

In the Cases above we found some practices common to all. Firstly, engagement with users was more than symbolic, to the extent that information users contributed substantially to the research, either as sources of data or by influencing design of communication products. Secondly, early adoption was matched by early communication that suited both the topic and the intended users of the research through media briefing, publishing an interim report and in many cases, conducting an inclusive face-to-face workshop. Thirdly, each project made use of invested stakeholders to promote the research, either through their host university media centres, peak body submissions to government or integration with industry programs. Finally, in addition to research dissemination arranged by NCCARF, each project ensured the reports were also accessible from a professional or university website.

We also found that Primary Investigators in each case committed considerable time and effort to take advantage of communication opportunities as they arose. Media attention often came to a research project because an external political or environmental issue generated requests for print, radio and television interviews in a short time. Similarly, it was helpful that Primary Investigators made themselves available for stakeholder meetings where research presentations reached senior decision makers who were influential in the user communities. In addition, engagement and communication with the users is ongoing as the researchers support knowledge adoption over time, referencing the work in the media, through conference and public presentations and in policy submissions.

Our first rough indicator of research impacts began with counting how many times the research was downloaded from the NCCARF website. While useful, this has limited value as we do not see how often a report was downloaded by each user, the volume of traffic on other sites where the research can be accessed, or if the reports have been used in any way. It is a simple metric however, which can be accessed on most well designed websites and so is widely available. Media attention is also one factor to indicate effective communication, especially when the greater public is an acknowledged user, as in Case 3. In both the United States and the UK, studies have shown up to a 63% increase in long term citations for research that drew significant media attention (Fanelli, 2012). In even this short time, we found evidence of research application in all cases through: requests for reports by user agencies; references to the research findings in submissions to government; application of the research in a professional practice, or in use of reports to inform adaptation research in other fields. As highlighted by behaviour studies such as those in case 3, adoption of climate adaptation related research faces issues beyond communication barriers to awareness and access to new knowledge. While the innovative measure of psychological adaptation posed by Reser and colleagues in the report for Case 3 is interesting in itself, it underscores the need for researchers to monitor the extensive adaptation to climate change already taking place across Australia and many other

countries, and could serve as a psychological indicator of public engagement with the issue.

From the cases we found that the elements of our assessment criteria as laid out in Table 2 form the basis for a strategic approach to researcher, end user and communication planning. The first four elements of our assessment criteria were explicitly addressed in each of our cases. This required a series of steps: identifying research users; negotiating how to involve users in the research, providing access to information while research progressed, and planning dissemination that suited the users. Of the last two elements, promoting the findings was treated in an ad hoc fashion that arguably benefited from the willingness of these particular Primary Investigators to engage with the media and stakeholder groups. Additionally, gauging uptake is essential as applying the research is the fundamental aim of the projects. From the outset it is valuable to articulate what uptake is expected, since the nature and speed of research uptake in adaptation planning varies considerably across the many sectors vulnerable to climate change.

CONCLUSION

Research to facilitate adaptation to climate change carries with it a sense of urgency that new knowledge be applied as soon as possible to address critical environmental, social and economic issues. In addition, the imperative to demonstrate swift research adoption comes from funding agencies whose reporting requires proof of near-term return on investment so agencies can compete for a share of shrinking budgets.

Importantly, research institutions and involved stakeholders supported quick and broad dissemination by actively promoting research communication, both within their sector and to the public. These final research reports were peer reviewed and had been published on the NCCARF website for between 9 and 12 months at the time this research was conducted. This is a very short timeframe to claim impacts from either academic citations by other authors or references in user or policy documents. Despite this, each of these research projects can demonstrate their use by stakeholders through reference in media reports and other publication, posting to user-specific websites, and in the case of asset management, extensive integration in planning and management processes.

In these cases considering stakeholders as information users and planning communication strategies at the beginning of research design have proven valuable. By maintaining an ongoing connection to stakeholders as sources of information during the research process these projects gained important insights into user information needs and also developed ongoing relationships which facilitated research communication and application when the final reports were published. Impact of NCCARF funded research will become more evident over time, and further evaluation will be required to address this effectively. Evaluating the uptake and impact of any future NCCARF funded research will be paramount.

ACKNOWLEDGEMENTS

This work was carried out with financial support from the Australian Government (Department of Climate Change and Energy Efficiency) and the National Climate Change Adaptation Research Facility.

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